TRANSPORT CONCEPT FOR PERSONNEL (NORMAL AND EVACUATION)

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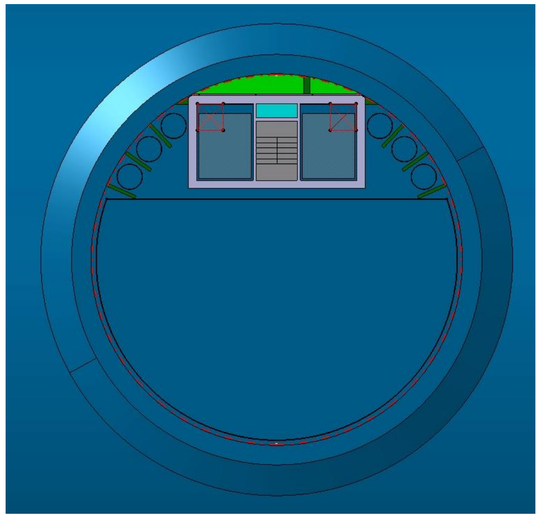
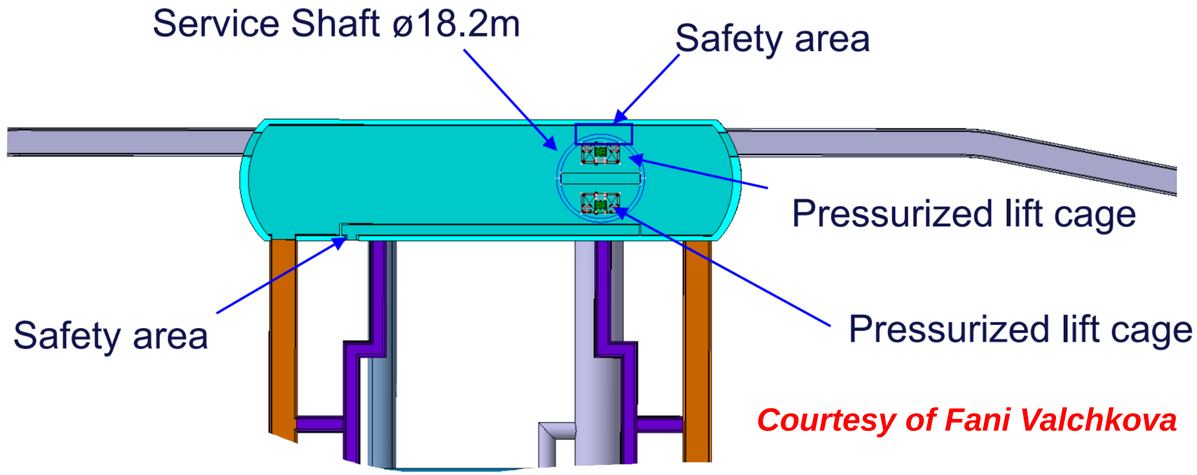
Personnel lifts

Key requirements:

- N. 2 or 4 personnel lifts hosted in the material shafts
- Capacity: 38 people / 3000 kg
- Travel: up to 400m
- Applicable standards:
  - EN81-20/50
  - EN81-72
  - EN81-73
  - prEN 81-76
- Max travel time: 126 s



Concept with 2 lifts per shaft

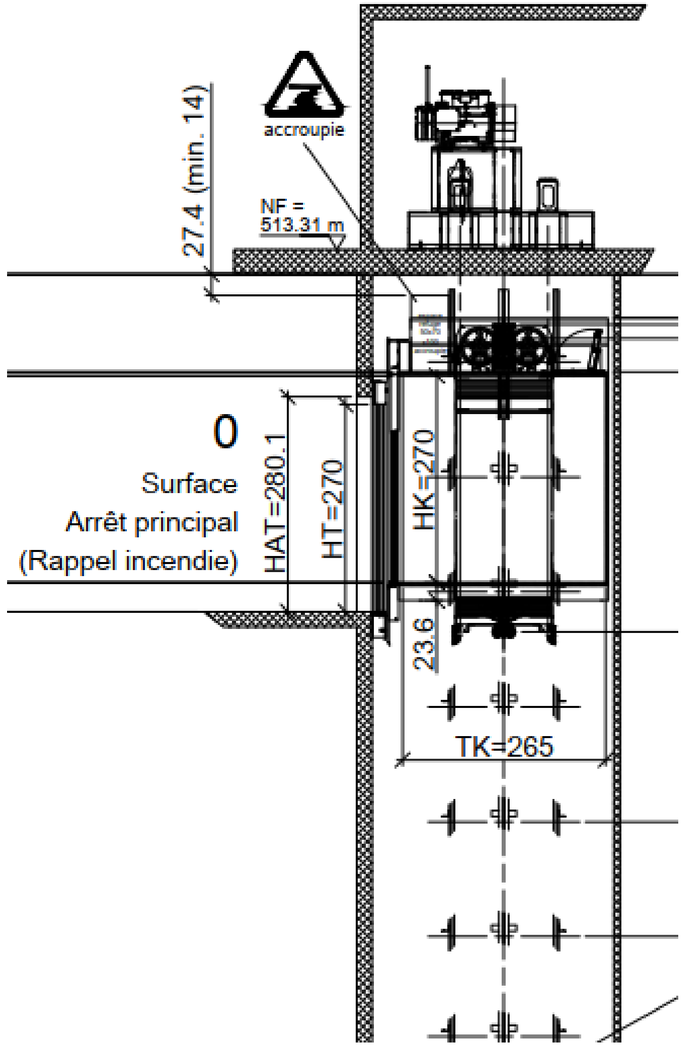


Concept with 4 lifts per shaft

Personnel lifts

- Rated speed: 3.5 m/s (max recommended speed = 4.5 m/s)
- Car dimensions: 2700 mm x 1900 mm
- Almost “standard” products, same LHC concept
- Bigger headroom than LHC -> possible impact on building height
- No need of special ropes

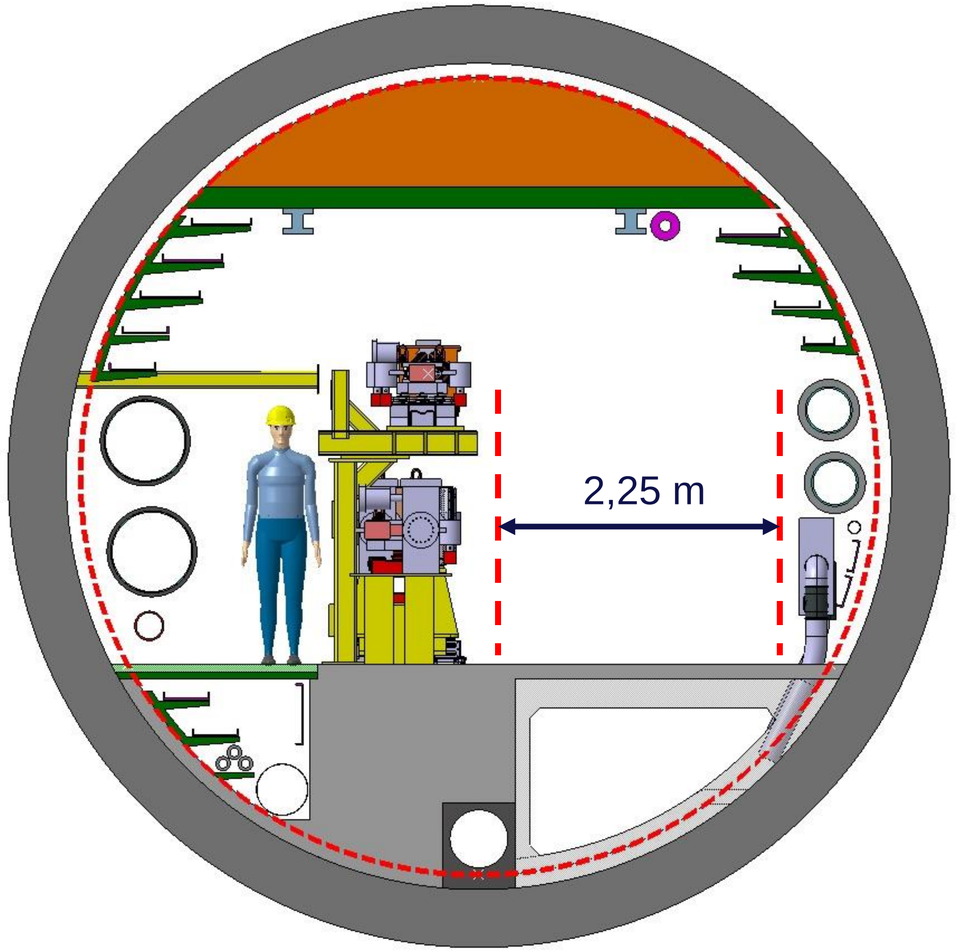
Example pictures and drawing of an LHC lift



Vehicles for underground transport

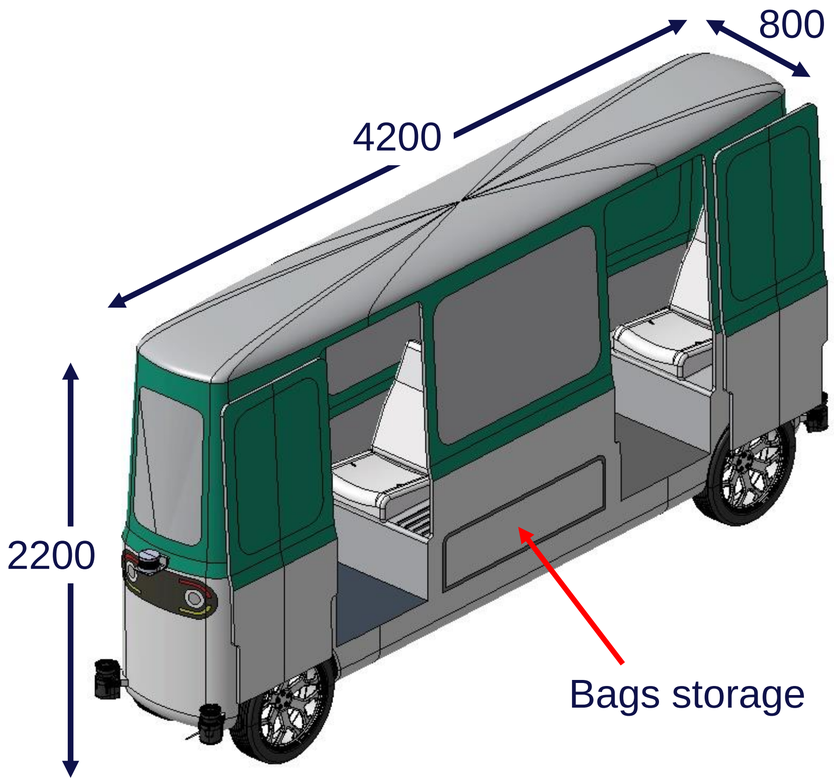
Key requirements:

- Capacity up to 6 people with luggage (540 kg)
- Slope: 0.5%
- Available driveway width: 2,25 m
- Autonomous motorized vehicles
- Closed vehicles able to drive through smoke
- Vehicles shall overtake each other anywhere in the tunnel
- Bi-directional drive



Vehicles for underground transport

- Symmetrical vehicle
- Overall dimensions: 4200 x 800 x 2200 mm (L x W x H)
- 4 seats maximum
- 4 bags (size equivalent to cabin luggage)
- Max speed: 30 km/h
- Battery driven; autonomy of 150-200 km
- Weight (fully loaded): 1500 kg
- Four steering wheels
- Line guidance
- Equipped with LIDAR sensors and laser scanners for autonomous driving



See next presentation *«Update on magnet and people transport vehicles and logistics simulation study»* for all the technical details

Transport concept in normal mode

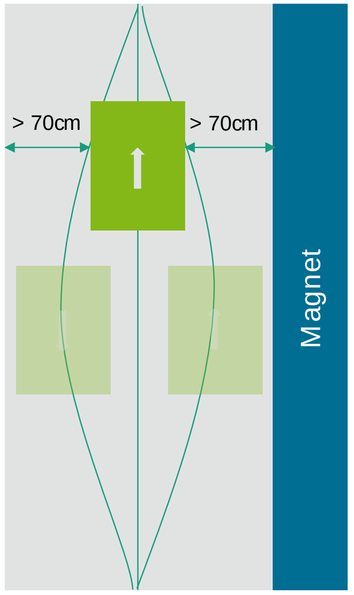
- People reach the underground via the lift in one of the SD buildings
- Vehicles pick up people in the service caverns
- Vehicles drive to the designated place of work of people (members of groups should be working in a close distance to each other)
  1. Vehicles drives on to the next alcove to park
  2. Vehicles stay close to the group they transported

  } **Impact on alcoves size and evacuation scenario**
- At the end of the working shift, the vehicle comes back to pick the group up and drive them to the same service cavern
- People reach the surface facilities via the lift

Transport concept in normal mode

Scenario 1: one centre lane

Vehicle steers laterally during entry/exit to the tunnel or whenever it crosses another vehicle.

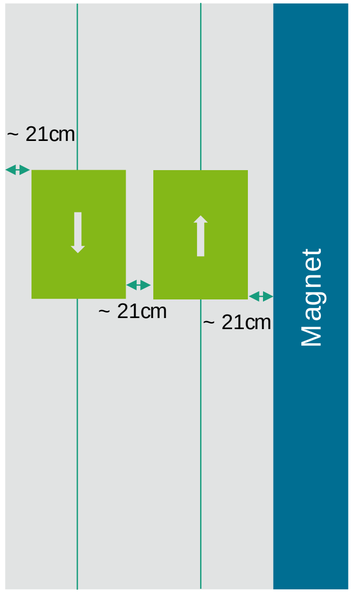


Maximum distance between vehicle and machine/wall

Overtaking a vehicle broken down in the driveway not possible

Scenario 2: two separate lanes

2.a: two dedicated lanes for normal driving

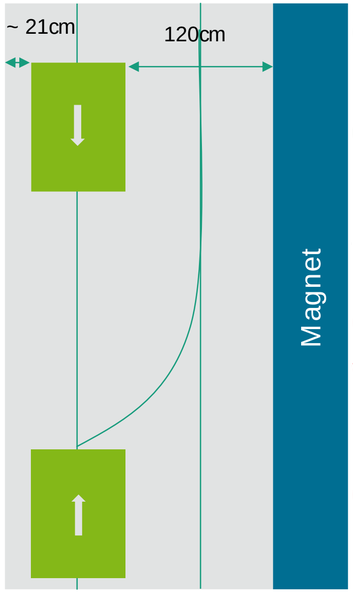


Overtaking a vehicle broken down in the driveway possible

No need to steer in case of incoming vehicle

Only 20 cm clearance with machine/wall

2.b: one dedicated lane for normal driving and one lane for vehicles crossing



Overtaking a vehicle broken down in the driveway possible

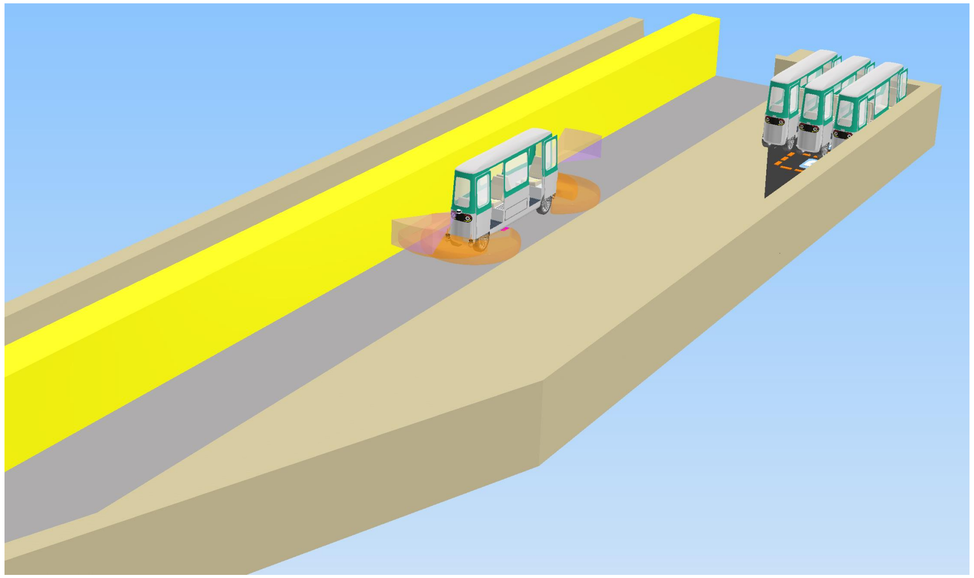
Maximum distance to the machine

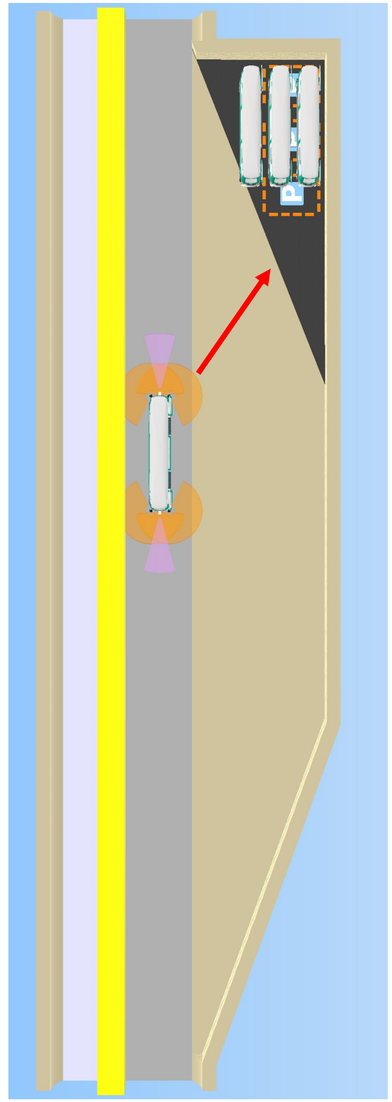
Only 20 cm clearance with wall

Need to steer in case of incoming vehicle

Transport concept in normal mode

- Parking manoeuvres are eased thanks to the four steering wheels
- With the current alcove design 3 vehicles can be parked





- An area for people pick-up to be foreseen in the service caverns
- Charging stations in the service caverns with dedicated ventilation

Transport concept in normal mode

Safety remarks:

- Need to make safe the passage of people in the service cavern while material is handled in the shaft
- Even if the vehicles are equipped with safety detection systems, driving speed shall be reduced in specific conditions:
  - Vehicles crossing
  - Driving next to an alcove
  - Driving close to people
- Driveway width cannot be less than 2,25 m with autonomous driving

Transport concept in evacuation mode

- In case of emergency, people walk to the next accessible alcove and take the vehicle to reach the safe area in the service cavern
- People walk to the pressurized area at the bottom of the shaft (same LHC evacuation concept)
- As ultimate solution use of manual scooters in the alcoves mounted to the wall like fire extinguishers to reach the service cavern, but:
  - Manual drive
  - High-number of scooters would be required
  - Scooters should be secured to prevent usage in normal situations

Transport concept in evacuation mode

Safety remarks:

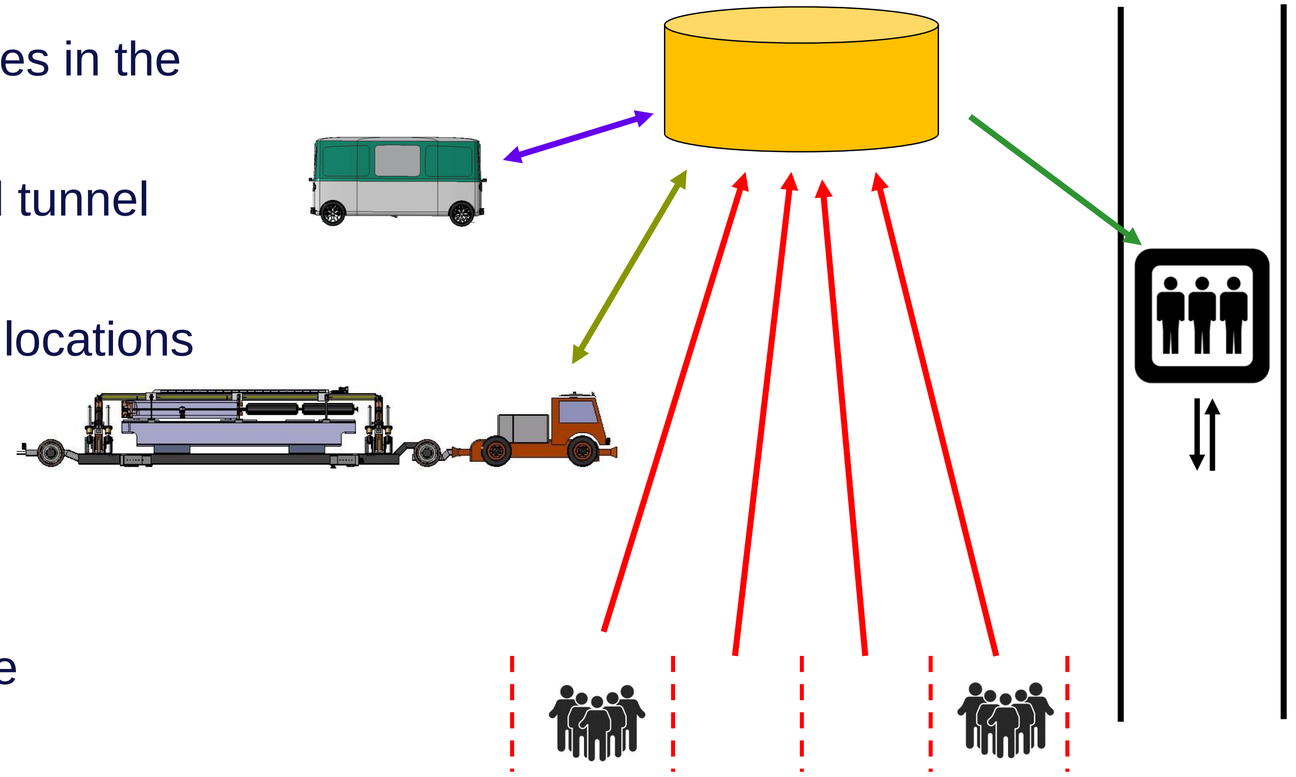
- Parking the vehicle close to the working location would make the evacuation time shorter
- Parking lots required in the service caverns
- If material transport vehicles will be circulating, they shall be directed to the next alcove to give way to people vehicles
- Vehicle design shall include specific features:
  - Functionality of detection sensors shall not be affected by the smoke
  - Pressurized cabin (for rescue vehicles / for normal vehicles only in emergency) ?
  - Include safety equipment on-board (fire extinguisher, first-aid kit, defibrillator…)
  - Possibility to evacuate the vehicle (glass hammer, removable window…)

Proposal for a centralized traffic management system

A centralized traffic management system would be crucial to optimize the number of vehicles and parking areas and improve the overall safety (less traffic, smoother evacuation).

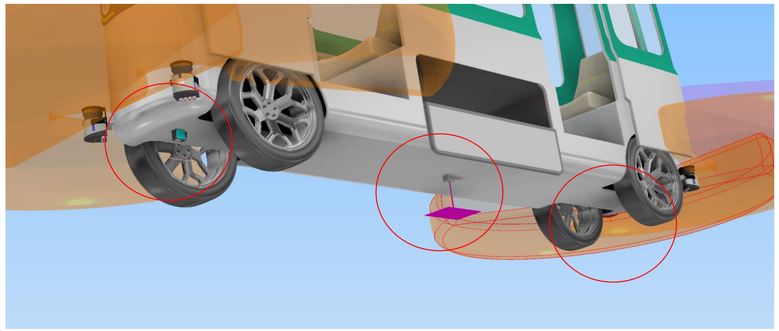
Main functionalities:

- Register the position of material and people vehicles in the tunnel and caverns
- Monitor the number of people working in a defined tunnel sub-sector
- Receive call for vehicles with pick-up and drop-off locations
- Manage vehicles to pick-up points
- Coordinate lifts call
- Inform the vehicles about the presence of people
- Inform the vehicles about another incoming vehicle
- Manage vehicles in case of emergency



Proposal for a centralized traffic management system

- Hardware:
  - Barcodes close to the guiding line and sensors on-board of the vehicles + encoders to retrieve the position between two barcodes

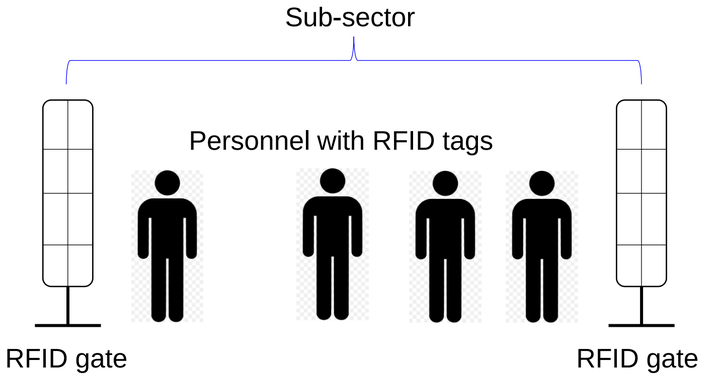


  - Radio-Frequency IDentification (RFID) gates to define sub-sectors in the tunnel and RFID tags embedded in the safety vests.

    To be defined: sub-sector length, fixed vs mobile gates

    OR

  - Vehicles themselves to be used to map the presence of people



- Network: redundant GSM/TETRA network to assure a safe communication in case of emergency.

Next steps

To finalize the technical aspects of the transport equipment and scenario, the following topics shall be further developed. Iterations with civil engineering, safety, integration, planning and coordination are needed.

- Lifts:
  - Shafts dedicated to transport people and number of lifts (experimental points)
  - Physical separation between handling shaft and personnel passage areas

- People transport vehicles
  - Battery type
  - Safety aspects of charging areas
  - Pressurized cabin on all vehicles or only rescue vehicles

- People transport scenario
  - Parking areas: tunnel or alcoves
  - Driving lanes
  - Boundary conditions for people vehicles with respect to material vehicles and people

- Centralized traffic management system

Thanks for your attention